COOLANT AND MACHINING DEVICE UTILIZING SAME

BACKGROUND OF THE INVENTION

The present invention relates to a coolant for preventing crevice corrosion of constitutional members or parts of a machining device or machining center such as including a machine tool provided with a linear motion guide, for instance, and also relates to a machining device utilizing such coolant.

A cutting oil agent (generally called "coolant"), which is widely known and used in cut working or cut grinding field, includes a water-insoluble coolant which has a base of mineral oil and is utilized without being diluted with water and a water-soluble coolant which contains mineral oil, surface-active agent, organic amine and so on and is utilized by being diluted with water (refer to JIS (Japanese Industrial Standard) K2241).

Recently, however, many severe requests have been increased with respect to machining conditions, environmental conditions and the like in accordance with the development of productivity of products. In accordance with such requirements, in the cut working or cut grinding field utilizing the water-insoluble coolant, many matters, for instance, concerning fuming (smoke), mist, firing and the like have been closed up.

Because of such reason, the water-soluble coolant has been widely utilized in the cut working and cut grinding working field such as lathe turning, boring, or milling working.

As such water-soluble coolant, there have been developed and known: (i) an emulsion-type water-soluble coolant which is prepared by adding surface active agent or organic amine to mineral oil as base oil of water-insoluble coolant to thereby make it possible to be diluted with water; (ii) a solution-type water-soluble coolant which is composed of mineral oil and surface active agent and contains much amount of surface active agent than that of the emulsion-type coolant; and (iii) a solution-type water-soluble coolant which does not contain mineral oil as base oil of the water-insoluble coolant and mainly contains water-soluble substance such as amine or inorganic salt.

Among the above-mentioned water-soluble coolants, the solution-type water-soluble coolant containing no mineral oil provides a problem or defect of deterioration of machine parts or members due to local corrosion based on its component composition. That is, the deterioration of the machine members due to the local corrosion may cause fault or accident of a machining device, degradation of quality or value or worth of product which is manufactured by such machining device.

Such local corrosion includes pitting corrosion or crevice corrosion, which may be generated to sliding portions in a linear motion guide device (LM guide), for example, utilized as a base machine or device of machine tool such as grinding machine or electric discharge machine.

In order to solve such problems or defects of local corrosion as mentioned above, there has been considered change of material constituting, for example, the linear motion guide device to a corrosion-proof material or improvement in sealing performance of, for example, a roller bearing such as disclosed in Japanese Patent Laid-open Publication No. 2002-310171.

However, in spite of the above fact, in the machining device utilizing the solution-type water-soluble coolant, it is difficult to essentially solve the above problems by the change of the constitutional material to the corrosion-proof material or by the improvement in sealing performance, and the problem of the deterioration based on the local corrosion still remains unsolved.

SUMMARY OF THE INVENTION

The present invention was therefore conceived in consideration of the circumstances in the prior art mentioned above for substantially eliminating defects or problems encountered in the prior art, and an object

of the present invention is to provide, in one aspect, a coolant in a state of solution in which a water-soluble substance is dissolved, wherein a sodium nitrite is added as additive by an amount of not less than 0.345 weight % for preventing crevice corrosion from causing.

The water-soluble substance may include amine and inorganic salt.

In a more specific embodiment, there may be provided a coolant in a state of solution comprising $0.1MNA_2CO_3$, 0.01MNaCl, 2 weight % of coolant solution, and a sodium nitrite added as additive by an amount of not less than 0.345 weight %.

There may be also provided a coolant in a state of solution comprising $0.1MNA_2CO_3$, 0.01MNaCl, 2 weight % of surface active agent, and a sodium nitrite added as additive by an amount of not less than 0.069 weight %.

In another aspect of the present invention, there is also provided a machining device, wherein a structural member of the machining device is composed of a material which reacts with a coolant including a sodium nitrite as additive by an amount of not less than 0.345 weight % for preventing crevice corrosion from causing.

The material constituting the structural member is a carbon steel for constituting the machine structure includes carbon of 0.07 to 0.61 weight %.

As mentioned above, according to the coolant of the

present invention, the sodium nitrite ($NaNO_2$) included in the coolant acts to suppress the crevice corrosion from generating to a machining device, and as a result, the degradation of the machine structural member due to the local corrosion can be suppressed.

In addition, the machining device such as machine tool utilizing such coolant is substantially free from fault or accident of the machining device based on the deterioration of the constitutional members or parts thereof due to the local corrosion. As a result, the machine can be stably and safely operated. Accordingly, products manufactured by such machining device could provide good quality.

The nature and further characteristic features of the present invention will be made more clear from the following descriptions made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Fig. 1 is a graph representing a current-voltage curve in a case that a concentration of a coolant is changed in accordance with one embodiment of the present invention;

Fig. 2 is a graph representing an example of a changing of a crevice corrosion at a time of changing

a concentration of sodium nitrite ($NaNO_2$);

Fig. 3 is a graph representing another example of a changing of a crevice corrosion at a time of changing a concentration of sodium nitrite; and

Fig. 4 is an illustrated perspective view of a machining center as one example of a machine tool utilizing the coolant of the present invention.

DESCRITION OF THE PREFEREED EMBODIMENT

A coolant and a machining device utilizing the coolant according to the present invention will be described hereunder with reference to the accompanying drawings.

Further, it is first to be noted that, the term "weight %" is equivalently used herein as "mass %".

The coolant of the present invention is a solution-type coolant which is preferably utilized in a machining device such as grinding machine or electric charge machine. The coolant is specifically characterized in that sodium nitrite ($NaNO_2$) is added in this coolant for preventing the crevice corrosion to the machining device. Composition of the coolant is not limited to particular one as far as the coolant does not contain the mineral oil as a base oil of a water-insoluble coolant and mainly contains a water-soluble substance such as amine and/or inorganic salt. Therefore, a coolant

applicable to the present invention is not limited in its kind and containing components as far as the coolant can prevent the causing of the crevice corrosion by adding the sodium nitrite.

In the preferred embodiment, the coolant contains the sodium nitrite in a range of more than (not less than) about 0.345 weight %. By adding the sodium nitrite of this weight %, it is specifically effective for suppressing the crevice corrosion to a member formed from a carbon steel constituting a machine structure containing carbon (C) of 0.07 to 0.61 weight %.

In the case of less than about 0.345 weight % of the sodium nitrite, it has been found that it is impossible to sufficiently prevent, from causing, the crevice corrosion to the member composed of the carbon steel constructing the machine containing C of 0.07 to 0.61 weight %.

On the other hand, although the upper limit of the content of the sodium nitrite is not specifically decided, it will be decided to be about 1.40 weight % because when the sodium nitrite of about 1.40 weight % is added, the effect for suppressing the causing of the crevice corrosion is saturated.

As mentioned above, the coolant of the present invention can suppress the causing of the crevice corrosion with respect to the carbon steel for the machine

structure containing the C of 0.07 to 0.61 weight %. This is because such carbon steel belongs to an intermediate acid, and the sodium nitrite belongs to an intermediate base. Thus, both the carbon steel and sodium nitrite are likely combined, and as a result, a film for suppressing the generation of the crevice corrosion is easily formed.

In addition, it may be possible to add, to the coolant of the present invention, a coloring agent, antiseptic agent, mildew-proof agent, copper-metal corrosion proof agent, anti-forming agent, pressure reducing agent, abrasion conditioner and the like. Furthermore, the coolant may be prepared by using distilled water, deionized water, city water, industrial water or like.

A machining device according to another embodiment of the present invention will employ one which effectively utilize the coolant of the characters mentioned above without specifically limiting its kind or type. Preferably, a machining device which constitutional member is formed from carbon steel containing carbon (C) of 0.07 to 0.61 weight % will be desired. As one preferred example, there will be listed up a linear motion guide (LM guide) utilized for the base of a machine tool such as grinding machine, electric discharge machine and the like.

Fig. 4 shows an entire outer appearance of one example of a machining device to which the coolant of

the present invention mentioned above is applicable. The example is a machining center, and more specifically, an NC (numerical control) machine tool capable of performing workings to plural surfaces of a work without changing tools. Such machining center is provided with an automatic tool exchanging function and automatic tool selecting function.

The machining center 1 of Fig. 4 comprises a working section 2 and a control section 3. The working section 2 includes an X-Y table 8 provided with a linear motion guide device, not shown, a work table 6 provided for the X-Y table 8, and a spindle 4 for chucking a tool 5 for machining a work (workpiece). The spindle 4 is moved in a Z-direction (vertical direction on Fig. 4) by the linear motion guide device. When machining the work, the coolant is supplied through a coolant supply nozzle, not shown, to a portion to be worked of the work. The working section 2 is generally covered by covers 7, 7, by which dust, work chips, coolant and the like can be prevented from scattering.

In the machining device utilizing such coolant, since the film for suppressing the generation of the crevice corrosion is formed by the reaction of the sodium nitrite in the coolant to the carbon steel, the deterioration, due to the crevice corrosion, of the machine constituting members or parts of the machining

device such as NC machine tool mentioned above can be substantially eliminated.

[Example]

Hereunder, an influence of the sodium nitrite in the coolant on the crevice corrosion will be described in detail through experiments which were carried out.

There was prepared, a round bar or rod member composed of S45C (a carbon steel for machine structural member containing carbon (C) of about 0.45 weight %) having a diameter of 10 mm and height of 25 mm, and the round bar had a ground surface condition. The round bar was then defatted by using ethanol, a copper wire was soldered to coat the upper portion and bottom portion of the round bar, and thereafter, an urethane rubber ring was fitted. The thus prepared round bar was used as a test piece for evaluating crevice corrosion.

As an electrolytic solution for evaluating the crevice corrosion of the test piece, there was prepared a solution of $0.1MNa_2CO_3$ solution to which 0.01MNaCl, coolant mainly containing surface active agent, sodium nitrite, sodium nitrate, and the like were added. The thus prepared electrolytic solution was used for the crevice corrosion evaluation by dipping the test piece into the electrolytic solution, and the evaluation was made through electrochemical measurement, under deaeration condition, by using a potentio-galvano-stat.

As the coolant, there was used NORITAKE Cool NK-81L(Manufactured by KABUSHIKI KAISHA NORITAKE Company Limited). The coolant has composition of surface active agent, which also acts as rust preventives, (40-50 weight %; organic amine salt, boric acid amine salt, organic amine, organic amanoide type rust preventives), non-ferrous metal anticorrosive (less than 0.1 weight %; triasol type compound), antiseptic agent (0.2 -0.5 weight %; xylenol type compound), and water (50-60 weight %).

[Experiment 1]

First, influence of the coolant on the crevice corrosion was considered.

Fig. 1 is a graph representing a current-potential curve in a case that the coolant concentration was changed in the "$0.1MNa_2CO_3$ + 0.01MNaCl" solution.

As can be seen from the graph of Fig. 1, a threshold voltage (built-up voltage) of current density was transited to a negative side by adding the coolant, and the crevice corrosion due to urethane rubber was considerably accelerated. For example, by adding the coolant by more than 1 weight %, the voltage (potential) was built up near 200 mV and the crevice corrosion was considerably accelerated. However, even if the coolant was further added, the threshold voltage was not so changed. Further, in a case where the coolant was added by more

than 1 weight %, a behavior like passive state area was observed in a range of 400 to 600 mV (vs. SCE).

[Experiment 2]

Next, an influence of the sodium nitrite in the coolant on the crevice corrosion was considered.

Fig. 2 is a graph representing a change of a corrosion potential in a case that the sodium nitrite concentration in a "$0.1MNa_2CO_3$ + 0.01MNaCl + 2 weight % coolant" solution.

As can be seen from the graph of Fig. 2, the corrosion potential was not changed till the sodium nitrite content increases to 0.069 weight %, but it was found that a threshold voltage (built-up voltage) of the current-voltage curve was rapidly transited to a positive side at the sodium nitrite of 0.345 weight %. The transition of the threshold voltage to the positive side shows the appearance of the crevice corrosion prevention effect. Further, it was found that even if the sodium nitrite is added more than 0.345 weight %, the threshold voltage is less changed, so that substantially the same effect could be attained by the addition of the sodium nitrite ($NaNO_2$) more than 0.345 weight %. According to this experiment, it was found that the high crevice corrosion prevention effect could be obtained by adding the $NaNO_2$ of more than 0.345 weight %.

[Experiment 3]

Next, an influence of the sodium nitrite and the

surface active agent on the crevice corrosion was considered.

Fig. 3 is a graph representing a change of a crevice corrosion potential in a case that the sodium nitrite concentration in a "$0.1MNa_2CO_3$ + 0.01MNaCl + 2 weight % surface active agent" solution. The surface active agent added in this solution was a "petroleum sulfonate" having molecular of 400-450, as anion type surface active agent, manufactured by SUGIMURA KAGAKU KOGYO KABUSHIKI KAISHA.

As can be seen from the graph of Fig. 3, it was found that the threshold voltage of the current-voltage curve was rapidly transited to the positive side by adding the sodium nitrite of 0.069 weight %. The transition of the threshold voltage to the positive side represents the achieving of the effect of the crevice corrosion prevention. On the other hand, even if the sodium nitrite is added by more than 0.069 weight %, the threshold voltage is not so changed, and in view of this fact, it was found that even if the sodium nitrite be added more than 0.069 weight %, further additional effect was not expected. Therefore, the improved high crevice corrosion prevention effect is obtainable by adding $NaNO_2$ of more than 0.069 weight % into a solution including anion-type surface active agent of 2 weight %.

[Experiment 4]

The following experiment was further carried out

on the basis of the results of the experiments 1 to 3 mentioned above.

In this experiment, the NORITAKE Cool NK-81L (Manufactured by KABUSHIKI KAISHA NORITAKE Company Limited) was used as coolant. A grinding solution added with the sodium nitrite of 0.345 weight % and a grinding solution added with no sodium nitrite were prepared, and grinding machines for using such grinding solutions were also prepared.

In the grinding machine utilizing the coolant added with the sodium nitrite, any crevice corrosion was not observed at its sliding portion. However, in the grinding machine utilizing the coolant added with no sodium nitrite, the crevice corrosion was observed at its sliding portion.

[Result of Evaluation]

As is apparent from the experiments mentioned above, it was found that, by adding the sodium nitrite, by a small amount, in the coolant, the threshold (built-up) voltage of the current-voltage curve is transited to the positive side and the generation of the crevice corrosion can be effectively suppressed. This is because that the ferrous component of the S45C (carbon steel for machine structure containing carbon (C) of about 0.45 weight %), as a test piece, belongs to an intermediate acid and the NO_2 also belongs to an intermediate base, and for this reason, these components are easily combined. Therefore,

as a result, a film which is capable of suppressing crevice corrosion can be easily formed.